The Newsletter of the Earth Sciences Directorate

Earth Sciences NEWS

NASA Goddard Space Flight Center Volume 3, Number 1, Spring/Summer 1998

A Message From the Director of Earth Sciences

The last time I wrote to you, we were about to begin the Center reorganization, TRMM had just launched, SeaWiFS was just picking up speed, and Joe Rothenberg was Center Director! In the last six months, Code 900 has accomplished much, and changes have occurred that affect Code 900. First of all, it is great to see Bill Townsend come to Goddard as the Deputy Director. He, of course, brings a plethora of knowledge and experience to the Center, particularly in the Earth sciences and the attendant programs, that will be of great benefit to the Center and to the Earth Sciences Directorate. On the other hand, I am sure we all mourn the loss of Dr. Robert (Bob) Price. He not only was a great proponent of the Earth sciences, but, more than that, was a close colleague and friend whom we miss greatly. The Center reorganization has occurred and the adjustment to those changes is taking place. We all need to do all we can to ensure that the reorganization is a success.

As usual, there are so many accomplishments that to mention any one runs the risk of leaving something out of equal or greater importance. Given that risk, I nevertheless cite the considerable scientific results pouring out from the TRMM mission and from SeaWiFS, and the progress for the NASA Seasonal to Interannual Prediction Project (NSIPP) accompanied by the upgrade of the Cray T3E super computer, as examples of the many fine things being accomplished in the Directorate. Good progress is being made with these and many other efforts that I probably am remiss in not noting specifically. I urge all of us to continue to monitor the Directorate organizational web pages for many other examples and indicators of the many activities and outcomes generated in the Directorate.

In the next months we do face many more changes and challenges. On the Projects side, the EOS AM-1 and Landsat-7 missions are coping with some considerable problems that are causing delays in the launch. The EOSDIS and other EOS Projects are affected to varying degrees; some of you may be called upon to provide guidance on resolving issues that may arise. We increasingly need to be thinking about, and providing leadership for, new scientific and accompanying technological thrusts out of which will come competitive and successful proposals for new work and support. Whatever the final results, I salute, as examples, the hard work accomplished by Jim Garvin, Dave Smith, and other colleagues in responding to the Astrobiology competition and the various proposal efforts underway for the ESSP-2 announcement of opportunity. The EOS Follow-on effort now unfolding will call for initiative, innovative thinking, and considerable effort of great importance to the Directorate and to the entire Center.

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TRMM'ing the Uncertainties: Preliminary Data from the Tropical Rainfall Measuring Mission

It's always a welcome situation when a recently launched satellite begins to transmit the data it was sent to acquire. The members of the Tropical Rainfall Measuring Mission (TRMM) science and engineering teams were elated when several of the instruments on TRMM recently demonstrated the robustness of their design by providing data that—in the case of the Precipitation Radar—even exceeded the science team's expectations.

The key objectives of the TRMM program are to obtain and study multi-year science data sets of tropical and subtropical rainfall measurements; understand how interactions among the sea, air, and land surfaces produce changes in global rainfall and climate; help improve modeling of tropical rainfall processes and their influence on global circulation in order to predict rainfall and its variability at various time-scale intervals; and test, evaluate, and improve the performance of satellite rainfall measurement techniques.

The primary scientific instruments on TRMM include the TRMM Microwave Imager (TMI), the Visible Infrared

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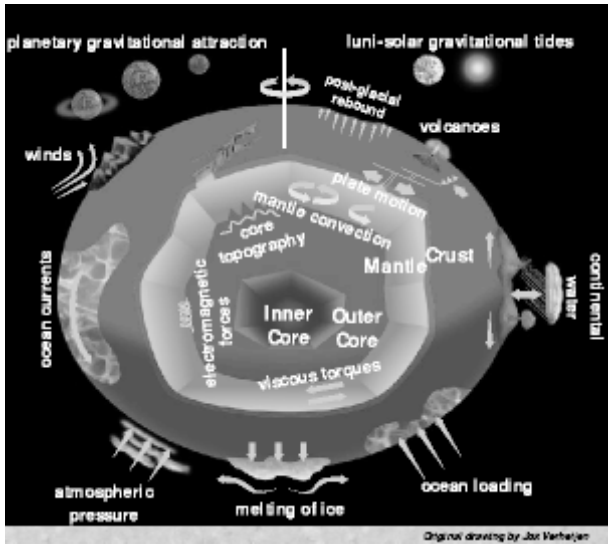
Laboratory for Terrestrial Physics Named as International Coordinating Center for Earth Rotation Research

Not in vain the distance beacons. Forward, forward let us range,
Let the great world spin for ever down the ringing grooves of change.

"Locksley Hall"—Alfred, Lord Tennyson



Depicted in this cartoon are the geophysical processes that can significantly change the Earth's mass distribution, and, hence, Earth's rotation and gravity field. Code 900 scientists are keeping close watch on these global changes and their effects.

How long is a day? Twenty-four hours, right? Well, plus or minus, anyway.

But, plus or minus how much, and why? That's the question!

Recent advances in instrumentation and technology have allowed Goddard scientists to determine that in February of this year Earth's rotation speed decreased by as much as 0.6 millisecond. It doesn't sound like much, but the implications are significant, for *something* had to speed up to make the Earth slow down, owing to the fixed amount of angular momentum in the Earth's systems.

In the present case, that something is the atmosphere, whose angular momentum was increased by the changes in air pressure distribution and wind movement associated with El Niño. In fact, the cumulative lengthening to date in the Earth's daily rotation rate due to El Niño is a whopping one-tenth of a second—about as long as an eye blink, says Dr. John Gipson of Code 926, the Space Geodesy Branch. The Earth's rotation will speed back up as El Niño dissipates, but this fine measurement, amounting to some seven billionths of the length of a day, is indicative of the exquisite instrumentation sensitivity available to scientists today. Scientists in the Earth Sciences Directorate work with scientists around the world to monitor the Earth's rotation and study the phenomena that lead to its changes, as shown in the Figure.

The Earth's rotational changes have implications for the daily activities of Goddard scientists and engineers who, for example, must determine exact satellite orbits and interplanetary spacecraft locations.

According to Dr. Ben Chao, Head of the Space Geodesy Branch, "If you want to track a spacecraft that is hundreds of millions of kilometers away, a small error in your tracking station location becomes a large error in the position of your spacecraft." As another example, consider the necessity of determining the location of the Earth in its orbit around the Sun and with reference to other planetary bodies. Or consider how much information is needed to measure the Earth's rotation to support other, celestial measurements. Even cosmology requires such techniques: Recently, "frame dragging," a phenomenon predicted by Einstein as a consequence of the interaction between matter and the curvature of space-time, was confirmed, using techniques related to those used to measure Earth's rotation rate. This work was published in *Science,* and was co-authored by Dr. Erricos Pavlis, of Code 926.

Techniques involved in such work support the International Earth Rotation Service (IERS), based in Paris, France. IERS is an international organization that maintains the International Celestial Reference System and the International Terrestrial Reference Frame. The IERS provides timely and accurate data on the Earth's orientation and thereby connects interdisciplinary research in astronomy, geodesy, and geophysics.

The permanent monitoring of the Earth's rotation requires the coordinated use of Very Long Baseline Interferometry (VLBI) and satellite techniques. By

measuring the time differences in the arrival of microwave radiation from extragalactic radio sources received at two or more radio observatories, VLBI provides the absolute reference for the determination of universal time, precession, and nutation. In fact, it is the only effective technique capable of measuring all components of the Earth's orientation—including polar motion—accurately and simultaneously. The main satellite techniques, including the Global Positioning System and Satellite Laser Ranging, provide independent, and oftentimes more frequent, determinations of certain important components of Earth's rotation. IERS collects data from these three different techniques, merges them into a unified reference frame, and releases them for scientific consumption and other practical uses around the world.

The irregularities in the Earth's rotation at all time scales are caused by motions of the Earth's fluid components, including the atmosphere, ocean, ground water, mantle, and core. These motions also modify the gravitational fields and give rise to motions of the center of mass of the planet relative to the crust, where the observing stations are located. Also, local influences of the fluids, such as ocean or atmospheric loading, must be evaluated to properly interpret signals derived from space geodesy, and ancillary aspects of properties of other fluids (such as the atmosphere and oceans) must be considered to properly interpret signals derived from the techniques of space geodesy relevant to the IERS mission.

To tie all these measurement activities together, the IERS requested proposals in February 1997 to establish a Coordinating Center for Monitoring Global Geophysical Fluids (CC/MGGF). The Coordinating Center deals with scientific research into geodynamic changes due to fluid mass and angular momentum transports, and requires the support of computation and data management facilities.

The selection of the Laboratory for Terrestrial Physics (LTP, Code 920) as the CC/MGGF was announced at the American Geophysical Union (AGU) meeting in San Francisco in December 1997. The selection was made after careful reviews and site visits by IERS's Directing Board, who emphasized the proximity of interdisciplinary teams of scientists and engineers at Goddard in their decision.

The CC/MGGF has the responsibility for coordinating and providing services to worldwide research efforts in Earth rotation, mediated by seven Special Bureaus that deal with mass transport in the atmosphere, ocean, oceanic tides, continental hydrology, mantle flow, gravity and geocenter, and the fluid core. The selection of these Special Bureaus was also announced at the AGU meeting in December. In addition to its Coordinating Center activities, the LTP was selected to host the Special Bureaus for oceanic tides, hydrology, and mantle flow.

The work is a collaborative effort among many members of Code 920, Raytheon STX scientists, and outside collaborators, led by Chao. A key feature of Goddard's winning bid to host the CC/MGGF was the presence of the Crustal Dynamics Data and Information System (CDDIS), led by Carey Noll of Code 922.

Dr. Chopo Ma (Code 926) stated that the CDDIS's proven experience in related activities helped GSFC provide a "...credible claim for both gathering and disseminating data and information" in support of the IERS application. Chao expects there to be little impact on the CDDIS from the additional responsibilities, with data volumes increasing by no more than 10 percent relative to current holdings and capacities. Also, many of the data and information activities will be carried out over the Web. However, additional manpower resources will be required to handle the increased need for data management, and to do related research.

Chao said that, "We must examine the current models, for instance, in dealing with ocean circulation. The next step is to use those outputs to calculate our parameters, store them, and distribute them when they are requested."

Ma added that, "The coordination center is a service function. It relies on GSFC's scientific expertise in modeling and geophysics and its expertise and experience in distributing data and information."

Says Chao, "A main reason we were selected is the proximity of the whole of Earth science research activities here at Goddard. This is a place that is unique in the world. I don't know any place other than Goddard that could support this kind of activity. We are honored to be recognized by the international community as a focus of global geodynamics research for the years to come."

[N.B.: Some material for this article was obtained from the IERS Web page at http://hpiers.obspm.fr/]

— Dr. Mitchell K. Hobish

Congratulations to:

Dr. Andrew Tait (Code 974/USRA) and his wife Rose on their marriage in New Zealand in March 1998.

Marshall Shepherd (Code 916) and Ayana Perez on their marriage May 2, 1998 in Atlanta, Georgia.

Condolences to:

The family and friends of Bob Price (Code 170), who died in March.

Marilyn Mack (Code 933) and her family on the death of her father in March.

Lee Foster (Code 933) and his family on the death of his mother in March.

Faye Richardson (Code 903) and her family on the death of her mother in April.

Cynthia Rosenzweig: From Hands-On Farming Under the Broiling Sun Of Tuscany to the Remote Sensing World Of Goddard

Although she now works in New York City, Dr. Cynthia Rosenzweig did not always have to rely on computers and models to learn what is happening on the Earth. In her twenties, she spent several years in Tuscany, Italy, where she lived and worked on an Italian farm and became fascinated with agriculture. She rented an old farmhouse and learned how to grow tomatoes, raise and milk goats (a Sardinian shepherd taught her how to make cheese), press olive oil, and pick grapes for Chianti wine. She also worked on a kibbutz in Israel, and later raised field corn and alfalfa in upstate New York. However, in her current role as Research Scientist at the Goddard Institute for Space Studies (GISS; Code 940) in New York City, Dr. Rosenzweig spends most of her time applying climatic information about global change to predicting the future of agriculture. In addition to her Goddard role, Dr. Rosenzweig is also Adjunct Research Scientist at Columbia University's Earth Institute and Adjunct Associate Professor at Barnard College.

Dr. Rosenzweig's early experiences on the land induced her to pursue studies in the environmental sciences, in general, and agronomy, in particular. She graduated from Cook College, the environmental science school of Rutgers University, receiving her B.S. degree with honors in 1980 and her Master's Degree in Soils and Crops in 1983. Later, she combined her research at GISS on climate-change impacts on agriculture with a Ph.D. program. The latter was conducted at the University of Massachusetts at Amherst, where she collaborated with Prof. Daniel Hillel, a leader in the field of soil physics and environmental hydrology, and Prof. Ray Bradley, an expert on paleoclimatology.

Dr. Rosenzweig's first work at GISS in the early 1980s was involved with the Large Area Crop Inventory Experiment (LACIE) program. During this period, she got her initial exposure to the application of satellite data to solve problems of agriculture. Her study team was headed by Dr. Sam Goward, now at the University of Maryland. Dr. Rosenzweig's role was to analyze how the various spectral bands, in particular the near infrared, can be used to evaluate crop health. After receiving her Ph.D. in 1991, she continued to develop her research at Columbia and was appointed to the permanent staff at GISS in 1995. She likes working at GISS because it is a stimulating and productive place to do science.

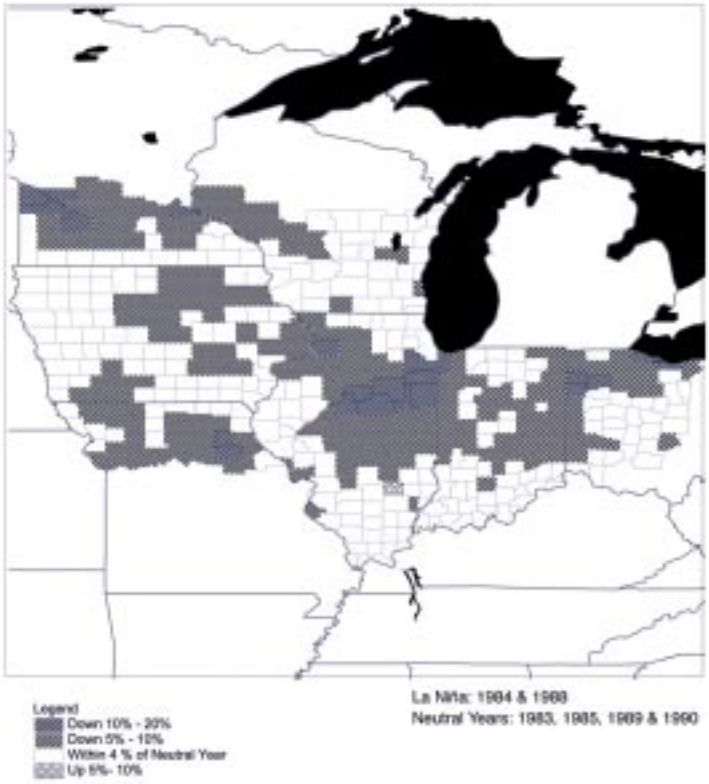
Dr. Rosenzweig, like so many other Goddard scientists, is strongly interested in outreach, with a particular interest in reaching out to women. A major activity in this area is teaching in the Environmental Science Department of Barnard College, a women's college allied with Columbia University, where she teaches Global Land Use and Habitability and Environmental Data Analysis. She finds the interaction with young women who are still seeking their way in the world to be very challenging, and she tries to open their eyes to the opportunities that await them in sciences, especially in the science of the Earth. She complements her outreach activities by giving talks about global environmental change to public schools and business groups, and by interviews with the media. When she gives public talks, she naturally tends to emphasize the role of remote sensing from NASA satellites in providing a worldwide perspective on climate and its interactions with agriculture and with natural ecosystems.

Summing up, Dr. Rosenzweig says: "I believe science is a great field for women. It's tough, but ultimately very rewarding in many ways, including the intellectual challenges, the collegiality (of, for example, the NASA Interdisciplinary Science [IDS] Teams), and the opportunity to work on globally significant environmental issues."

Dr. Rosenzweig's major current activity in her role as Principal Investigator on an IDS study as part of the Earth Observing System (EOS), entitled "Impacts of Interannual Climate Variability on Agro-Ecosystems and Fisheries." This is part of a comprehensive NASA effort to expand the scope of EOS. The study was launched in October 1996 and is to run for three years. However, the Team hopes to continue for the next several years in order to expand the work from four separate study regions to a global scale.

Dr. Rosenzweig is supported by a large

project team that is truly interdisciplinary. It includes specialty groups on El Niño Southern Oscillation (ENSO) forecasting, global climate modeling, remote sensing, agriculture, fisheries, and economics. The ENSO group is led by Mark Cane of Columbia's Lamont-Doherty Earth Observatory; the global climate modeling (GCM) team is headed by David Rind of GISS; the remote sensing activity is conducted by Jim Tucker and his group at GSFC; the fisheries study is led by Tony Busalacchi of GSFC; and the economics study is spearheaded by Geoffrey Heal from Columbia University. Dr. Rosenzweig is coordinating the project as well as focusing on agriculture. Three subteams contribute specialized regional knowledge: Ephias Makaudze of the University of Zimbabwe is the specialist on African agriculture; Walter Baethgen (International Fertilizer Development Center) provides the expertise on South American agriculture; and William Batchelor of Iowa State University brings U.S. Cornbelt research expertise.



La Niña affects crops negatively in the U.S. Cornbelt, as shown by the AVHRR Normalized Difference Vegetation Index (NDVI).

The research is multi-regional as well as interdisciplinary. As noted above, the study regions include parts of the United States, Africa, and South America. The regions were chosen for their differing vulnerabilities to climate variability. Dr. Rosenzweig points out that this effort is not merely research for its own sake. There is a "user pull" for information on climate impacts from farmers, consumers, and commodity brokers; as well as related interests such as the industries that deal with fertilizer, storage, and processing of agricultural products.

Dr. Rosenzweig relates: "To be useful, information about weather and climate must be given at appropriate spatial and temporal scales. Sometimes it's enough to know about climate for a whole region, but at other times you need to know about the climate in a particular county or valley. The variation of rainfall from day to day or week to week is important, especially to crop development. Our IDS project explores the usefulness of predictive information to a variety of user groups at differing temporal and spatial scales."

The project has conducted a set of simulation experiments with the GISS global climate model (GCM). For instance, global sea surface temperatures, as they have been observed for the period 1979 to the present, are used to drive the GCM. In other simulations just sea surface temperatures observed or predicted for the tropical Pacific are embedded in the GCM. These experiments have shown that the GISS global climate model is capable of simulating effects on climate around the world associated with El Niño events that take place in the equatorial Pacific Ocean. In other project studies, strong relationships have been found among sea-surface temperatures, regional climate variables, vegetation health, and crop yields in Zimbabwe and Brazil.

The project has been using sequences of satellite images (both AVHRR and Landsat) to show how agricultural regions have changed over time. One place that is being examined intensively is the Cerrados region of Brazil. Here, one of the most rapid agricultural transformations in the world is taking place as the vast savanna ecosystem is being converted to commercial soybean fields and intensive pastures.

The project intends to make use of the ASTER instrument on the EOS AM-1 platform, scheduled for launch this year, by tasking it to make special sequences of measurements for the U.S. Cornbelt. ASTER is a Japanese instrument which will offer fifteen-to-ninety-meter resolution in the visible and infrared portions of the electromagnetic spectrum. These channels will make possible the detection of such changes in crops as water stress, and the characterization of specific crop fields. Surface temperature measurements from ASTER can be combined with other measurements to arrive at estimates of the amount of water evaporated into the atmosphere from the soil and from crop canopies.

Dr. Rosenzweig is the author of research

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TRMM'ing the Uncertainties:….

Scanner (VIRS), and the Precipitation Radar (PR). These three instruments work in a complementary manner, and serve as a kind of "flying rain gauge." The VIRS will bridge the gap from the TRMM rainfall estimates to those estimates made with geostationary and low-Earth-orbiting satellites using visible/infrared techniques. This will help overcome the temporal and spatial sampling problem inherent in a single satellite's coverage. This primary complement is accompanied by the secondary scientific instruments, a Clouds and the Earth's Radiant Energy System (CERES) and a Lightning Imaging Sensor (LIS).

The TRMM observatory was successfully launched on November 27, 1997 from Japan's Tanegashima Space Center by a Model H-II launch vehicle. The 96-minute orbit is inclined 35° to the Equator and is circular, with an altitude of 218 nautical miles (350 km). This orbit allows collection of tropical rainfall data from the passive microwave sensor (TMI) every 16 orbits, with a diurnal precession rate arranged so that it comes over any given point roughly an hour later each day, and repeats approximately every 30 days. The orbit was intentionally kept low in order to distinguish radiances over the 10 km scales typical of convective clouds.

"It's really too early to draw conclusions about total rainfall estimates," says Dr. Chris Kummerow, the TRMM Project Scientist, "but indications are that the data coming down from the recently calibrated sensors will make significant contributions to our understanding of rainfall mechanisms and processes."

That's not to say that the preliminary data aren't useful; quite the contrary.

Indeed, Kummerow noted that, "With TRMM's high-resolution radar data, passive microwave data, infrared (IR) data, and lightning data, we are finding unambiguous evidence that the passive microwave is consistently indicating more rainfall over the oceans than the infrared, and consistently less rainfall over the land than the IR. The lightning data show that lightning is confined almost strictly to over-land cases, with very little lightning over the oceans."

He continued, "The nice thing about TRMM is that we can subset all the different data sets to exactly the same time and area. We've known for a while that the physics from IR data from geostationary sensors wasn't as good as that from passive microwave. But, by virtue of looking at a scene basically all the time, it does provide better sampling. But we could never untangle how much of what we saw was due to sampling and what was due to errors. So, by being able to subset everything to the same sampling, we can start to look at the physics."

Such insights allow the TRMM team to explore the differences in ice scattering between over-land storms and oceanic storms. Said Kummerow, "Ice scattering at the shortest wavelength of the passive microwave sensor appears to be about the same in these storms. That, we think, indicates that the total amount of ice is roughly equivalent in oceanic and land storms. But, when we start going to longer wavelengths, the ocean storms don't show any signature. We think that's because the ice crystals are smaller in the oceanic storms."

Such surmises would acquire increased validity with more thorough analysis and with collection of data from aircraft flights through the storms, synchronized with TRMM passes. The aircraft studies began in April in Houston, then will move to Florida in the summer, Brazil in January 1999, and the Kwajalein Atoll in September 1999. In conjunction with ground-based radar studies these data will allow TRMM scientists to determine just what is happening in these storms.

The TRMM science team already has had a few surprises, requiring some fast reworking and development of algorithms to analyze the data. Initial radar data analysis has given indications that estimates of radiative transfer to space may be in error. According to Kummerow, this could come from the models' not putting enough liquid into the atmosphere to match the passive microwave observations. One possible source of error is the drop-size distribution. Kummerow said that, "The raindrops don't all come down in the same size; there's always a distribution of drops, and it's the mean of the distribution that affects the radar. It's clear from these early experiments that something we're doing is not quite right. We may be assuming that the drops are too big, but the most likely mistake is that we're assuming that the drop-size distributions are the same from the surface all the way up."

While drop sizes have been measured near the surface, it is very difficult to get drop-size distributions above the surface. Kummerow says that, to a first-order approximation, this may be the source of the error. The mechanisms of drop-size growth or diminution may be critical to understanding several phenomena. Drop size in stratiform storms, which generate relatively gentle rain, likely diminishes due to evaporation as the drops travel through the atmosphere. On the other hand, in convective storms the raindrops may continue to grow through accretion as they descend.

"None of that has really been incorporated into rainfall algorithms. It appears as though it could have a fairly big impact," said Kummerow. But now, with TRMM data covering footprints much smaller than those used previously, details should be forthcoming. He continued, "The tropical rain systems are mostly driven by sporadic convection—thunderstorm convection. A lot of the mid-latitude rain falls from frontal bands. There's every reason to expect

that these two have very different dynamics and have very different features in them. We're very lucky in that TRMM goes as high as 35° latitude. At 35° we do catch a lot of wintertime frontal precipitation."

Several other research and operational areas have been affected by the preliminary TRMM data.

For example, TRMM has pointed up some difficulties in interpreting rainfall echoes from ground-based radar data. According to Kummerow, "When you get sufficiently far away from ground-based sites, ground-based radars can start intercepting the region where the snowflakes melt, giving you very, very large echoes that are not really surface rainfall. This problem is well known to the radar meteorology community, but it's a huge problem when you start providing operational accumulations that are then used to drive models in terms of surface moisture. TRMM, even with only occasional overpasses, may be able to sort out some of these ambiguities."

Another area opening up for discussion deals with the processes that give rise to so-called "warm rains," such as are found in Hawaii. In Hawaii, these rains are orographically induced, i.e., when very moist Pacific air runs into the mountains it's lifted up a little, and water condenses out—dramatically. Hawaii is the rainiest place in the world, and yet these rains have no signature in the IR.

"Most IR algorithms don't assign rain until you get to about 235 K, said Kummerow, "so we're talking about 40° below zero, Celsius. So, when you have these clouds that never reach freezing level, the IR says (by and large) that there's no rain." The passive microwave sensors over land cannot see anything but ice particles in the clouds, and raindrops over land are indistinguishable from the land itself. "So the passive microwave sensors have been happily assigning a zero rain rate to the rainiest place in the world," says Kummerow. He continued, "With the TRMM precipitation radar we're going to start looking at how much rain we're really missing. We also need to know in how many places this occurs. We know about Hawaii; there are places in India that favor this kind of precipitation. But we don't really know how important it is to global processes: is this a big chunk of rain that we're missing, or is it just a scientific curiosity?"

The answer to this question is important because the total amount of energy that is released in the atmosphere and drives the worldwide atmospheric circulation is directly proportional to the total amount of rain that falls.

Another area that is being examined is the effect of the diurnal cycle on rainfall. Climate modelers need to know that they are capturing the diurnal cycle properly, because this will tell them if their models properly drive the convection.

"Nagging questions about the accuracy of the physics in the models, the amount of warm rain, and the effects of the diurnal cycle have left us with an uncertainty in global rainfall of about 30%," says Kummerow. "The TRMM observations and the physics we are starting to understand will have a huge impact on our ability to quantify rainfall processes. Reducing errors to less than 10% is certainly achievable using all the sensors that we have today and will even improve our estimates from previous years as well as into the future."

The data are being closely held until mid-May to allow the TRMM team to ensure that the data they release to the larger science community is of decent quality, and that it is all formatted properly. They see this as but another service to the community, part of their mandate to provide TRMM data, and to help us understand how rainfall affects—and is affected by—our environment.

— Dr. Mitchell K. Hobish

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Cynthia Rosenzweig. . .

papers in many international journals including *Nature*, *Climatic Change*, and *National Geographic Research and Exploration*. Recently, she led an international research project with scientists in 25 countries, assessing the potential impacts of increasing carbon dioxide and changing climate on world food supply and trade. The results of this project were reported in the Intergovernmental Panel on Climate Change, Working Group II volume on Impacts and Adaptations. She has edited two books on climate and agriculture. Most recently, she co-authored, with Dr. Daniel Hillel, the book, *Climate Change and the Global Harvest,* Potential Impacts of the Greenhouse Effect on Agriculture, just published by Oxford University Press (1998). The book provides state-of-the-art information in regard to climate-change impacts on agriculture and world food security.

Dr. Rosenzweig was elected Fellow of the American Society of Agronomy in 1996, and is serving as national chairperson of Women In Agronomy this year. She is preparing a symposium on the impacts of the 1997-1998 El Niño for the American Association for the Advancement of Science.

Dr. Rosenzweig is married and has two children, who are in their early 20s. She enjoys travel and is conversant in Italian and French. She loves hiking in the mountains and is a voracious reader of historical fiction.

— Renny Greenstone

Exploring Martian "Canals" and Other Interesting Features—MOLA

A Little History First

In modern days, our own Laboratory for Terrestrial Physics (Code 920, headed by Dr. David E. Smith) is in the forefront of research groups studying the topography of Mars, using the latest in scientific instrumentation and NASA's satellite "know how." Before seeing what our own Goddard scientists are contributing to the new knowledge of Mars, it is interesting to look back about a century ago to see what had caused a lot of public excitement about the possibility of life on Mars, the planet known to antiquity as the "red planet."

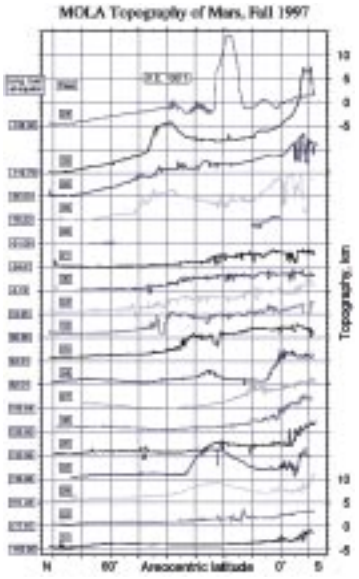
Giovanni V. Schiaparelli was the Italian astronomer who set off the wave of excitement about the "canals" on Mars. Actually, his countryman, Angelo Secchi, had developed the idea of the canals ten years earlier. Schiaparelli prepared the first modern astronomical map of Mars in 1877, and it was his map that showed for the first time indications of a system of *canali*, or channels, on some bright areas. The idea of an interconnecting system of canals on Mars provoked discussions as to whether there was life on Mars to account for the presence of the canals. The American astronomer, Percival Lowell, was particularly responsible for popularizing the notion that the linear markings (suggesting the presence of the canals) were the result of biological activity. Of course, we know today that there are no canals on Mars at all, but the large outflow channels that we have confirmed do attest to the role of water on Mars.

In 1894 Lowell founded an astronomical observatory in Flagstaff, Arizona. He spent a good deal of his professional life using a 24-inch telescope at the observatory to study linear features on Mars as well as the seasonal changes in the Martian polar caps. His theories about the habitability of Mars were based on his estimate that Martian temperatures averaged 8.9°C, and his theories were further enhanced by his observation of clouds. One such cloud on the Martian day/night boundary (called the "terminator") was estimated to be about 27 kilometers high, "a tawny color, of the tint exhibited by a cloud of dust," with an extent of 480 miles. Perhaps this was a cloud over Olympus Mons?

Even in 1910 the Encyclopedia Brittanica (11th Edition) reported doubts that the canals were waterways, noting that their breadth of many miles made it absurd to call them canals, but did suggest that the seasonal changes were evidence of blue-green vegetation. Lowell maintained that the linear features were indeed of artificial origin. Unfortunately, Lowell's descriptions were flawed. Even in Lowell's own time contemporary astronomers, Antoniadi and Hale, disputed the geometrical patterns that he termed canals, and few believed them to be waterways. And so we come to MOLA.

Now Back to MOLA

MOLA is the Mars Orbiter Laser Altimeter, an instrument developed by members of the MOLA engineering and science team. The majority of the instrument team is located here at Goddard. Dr. David Smith is the Principal Investigator, with Professor Maria Zuber of MIT serving as Deputy Principal Investigator and Dr. James Abshire serving as chief engineer. Through direct measurements, MOLA has been providing invaluable *quantitative* data on the shape of Mars and on various geological features. Such patterns, already revealed *qualitatively* by the Mariner and Viking spacecraft, are unlike anything described by Lowell. While the team does not expect to find "canals," it is confident that MOLA will be able to resolve features on Mars that are at least 200 meters wide and higher (or deeper) than a few tens of centimeters.



View of 18 MOLA ground tracks showing surface topography of Northern Hemisphere of Mars

How Are We Studying Mars Today?

Unlike the astronomers of the pre-spacecraft era, who were limited to describing features in the sky that they could see through their Earth-bound telescopes, today's astronomers can use NASA's technology to send spacecraft to the planets to study them either directly, from landers, or by means of orbiters carrying precision instruments around the planets.

NASA's planetary explorations go back to the days of Mariner fly-bys, and then to the days of Viking spacecraft landings. We were able to learn something about Mars topography from those early missions, but greater accuracy and precision had to await new developments in altimetry that are now coming through the efforts of the Goddard team.

MOLA-2 is a key instrument on the Mars Global Surveyor (MGS) spacecraft, which was launched November 7, 1996. The MOLA-2 instrument was designed by the Laser Remote Sensing Branch, headed by Dr. James Abshire of the Laboratory for Terrestrial Physics, with support from the Engineering Systems Analysis Branch. It is a lineal descendant of a very similar MOLA instrument carried aboard the ill-fated Mars Observer spacecraft, which was launched September 25, 1992. Unfortunately, contact was lost with Mars Observer on August 22 1993. Professor Zuber, who was then at Goddard, was the lead author of a 1992 paper in the Journal of Geophysical Research describing the MOLA instrument.

In its mapping mode MGS will be in a nearly circular orbit about Mars with an altitude of approximately 400 kilometers above the Martian surface. The orbital period will be 117 minutes, repeating approximately every 7 Martian days. MOLA-2 is a laser altimeter with a range precision of 30-40 centimeters, and 330 meters horizontal resolution.

The MGS spacecraft will circle Mars once every two hours in an orbit designed so that it always maintains the same orientation to the Martian terminator. This will put the Sun at the same angle above the horizon in each image, allowing the mid-afternoon lighting to cast shadows in such a way that surface features will stand out. The spacecraft instruments will be used to acquire data on Mars for a full Martian year. Afterwards, the spacecraft will be used as a data relay station for signals from U.S. and international landers and low-altitude probes for an additional three years.

Other instruments on board MGS are the Mars Orbital Camera, the Thermal Emission Spectrometer, the Magnetometer/Electron Reflectometer (developed under the leadership of Dr. Mario Acuña here at Goddard), and the Mars Relay. Radio science will also be performed using an ultrastable oscillator in the spacecraft's downlink telemetry subsystem as part of atmospheric and gravity investigations.

What are the Objectives of the MOLA Experiment?

One of the main objectives of MOLA is to map out the global topography of Mars by establishing a 0.2° x 0.2° grid with a vertical accuracy better than 30 meters. This is the sort of information that will be suitable for addressing problems in geology, geophysics, and atmospheric circulation. Examples of the problems to be addressed include mapping of the northern and southern ice caps, the depths of some of the deepest valleys in the solar system, and the heights of some of the highest volcanoes in the solar system. MOLA measurements will serve as a foundation dataset for future Mars exploration as a natural base map on which to overlay new information.

How Does Laser Altimetry Work?

MOLA, as it orbits Mars on the Global Surveyor, fires short pulses of infrared light at the surface and measures the time for the echoes to return, which then gives a measure of the distance from the spacecraft to the surface. Knowing the height of the orbit and where the spacecraft is pointing, it is then possible to map out the heights of Mars' mountains and the depths of its valleys. A telescope focuses the light backscattered by terrain, and possibly by clouds, onto a detector. Four separate channels sample the return pulses spread out by the roughness of the terrain below the spacecraft, increasing the likelihood of detection of the surface, and providing some information about the surface roughness characteristics.

Goddard scientists hope that MOLA-2 will be able to measure changes in surface elevation of the polar ice cap that result from the change of seasons.

What Have We Learned So Far from MOLA?

Just recently, a special section of *Science* magazine (March 13, 1998) was devoted to the Mars Global Surveyor Mission. In that section there is an article by Dr. Smith and other members of the MOLA team, including Dr. Herbert Frey, Dr. Jim Garvin, and Dr. Jay Zwally, all from Goddard. The most remarkable finding, based on the first eighteen tracks of MOLA data across the northern hemisphere of Mars (acquired in the fall of 1997), is the exceptional flatness at latitudes north of 50°. This came as a surprise (slopes and surface roughness increase toward the equator.) When we think about the early, comparatively primitive work of Schiaparelli and Lowell it is interesting to note that MOLA is teaching us so much more about the Martian channels than those pioneers were able to discover. As the article in *Science* tells us, there definitely are outflow channels on Mars: "Outflow channels and valley networks on Mars preserve the record of a period when liquid water flowed on the surface." Because of the high-quality MOLA measurements, particularly its refined measurements of slopes and channel depths and shapes, the MOLA team was able to conclude that the discharge rate for a channel in the region of Mars called Ares Vallis was an order of magnitude greater than had been estimated by other researchers.

— Renny Greenstone

SPOTLIGHT on EDUCATION

Bringing MARS Exploration into the K-12 Classroom: The MARS Orbiter Laser Altimeter Education Program

The Mars Orbiter Laser Altimeter (MOLA) Education Program is designed to involve students in the excitement of Mars exploration and to engage them in the scientific research process. (See MOLA article on pg. 8.) Partnerships have been formed with three NASA-funded education projects: The Maryland Teachers Ambassador Program at Goddard Space Flight Center, Explorers of the Universe at Tennessee State University, and the NASA CERES Project at Montana State University. In each case, students and teachers are working with MOLA and other Mars data in the context of K-12 science and mathematics curricula. Lessons and hands-on activities developed within these projects have been presented at teacher workshops during American Geophysical Union and Geological Society of America meetings. A similar workshop was held at the National Science Teachers Association meeting in April, 1998.

Going to Mars is a middle school Earth science unit which uses comparative planetology to teach Earth science concepts. The project grew out of Goddard's Maryland Earth and Environmental Science Teacher Ambassador Program. The program includes four weeks of summer training for Maryland science teachers in Earth system science and in computer and Internet use. In addition, each teacher who participates is partnered with a Goddard scientist who mentors the teacher during the school year. *Going to Mars* was developed as a result of this scientist-teacher partnership.

Students were challenged to find a landing site on Mars where they would have the best chance of finding evidence of Martian life. In order to do this, they first had to explore where and how fossils are preserved on Earth. As they learned about geologic environments on Earth, they began to compare Earth geology with Mars geology through the use of Mars controlled photomosaics and geologic maps.

Tom Albert, the sixth grade teacher, created a number of hands-on activities which allow students to explore geologic concepts within the course of their mission planning. The laboratory exercises include: (a) Stream Tables and Channels on Mars; (b) Layering and Core Sampling; (c) Soil Characterization (with Lunar and Martian soil simulants); (d) Comparison of Mars and Earth

Geologic and Topographic Maps; and (e) Impact Cratering.

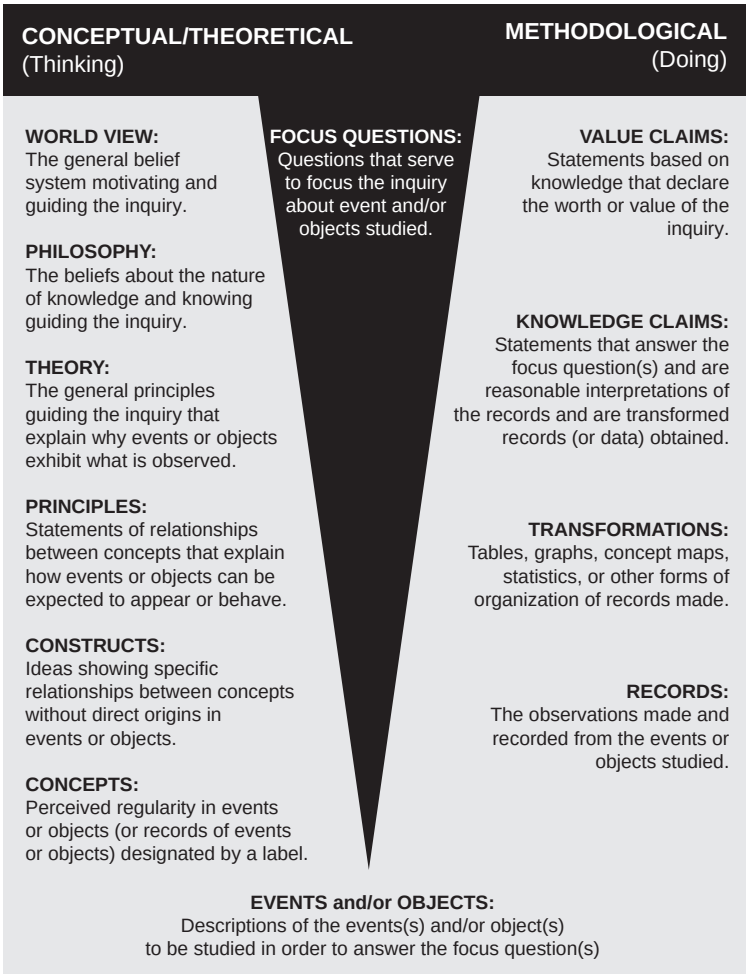
Once students have completed their background research, each class is divided into groups, with each group choosing one landing site. Students then participate in a peer review process that includes both oral and written presentations to select two landing sites for each class. Once landing sites are selected, each class plans its mission by regrouping into Launch, Flight, and Landing teams.

This project demonstrates one way in which current science exploration can be incorporated into a pre-existing curriculum. Each lesson and activity, while built around Mars exploration, also meets the objectives of the local school system science curriculum.

The Explorers of the Universe project (http://coe2.tsuniv.edu/explorers) is a scientific literacy project based at Tennessee State University (TSU) within the Center of Excellence in Information Systems Engineering and Management. The project is engineered by Marino C. Alvarez, Ed.D., of Tennessee State

University's Department of Teaching and Learning within the College of Education.

The project teams scientists with students and teachers at a number of different public and private secondary schools. The students perform research and data analysis. They interact with scientists and other school research teams via e-mail and websites. The MOLA case studies will have students utilizing laser altimetry from MOLA to study surface features on Mars. They will then compare and contrast topographic features on Mars with features in their local area. Results of case studies will be posted on the Web.



While the focus of the project is on scientific literacy, there are a number of components to it. Among other things, the project explores the use of interactive technology within middle and secondary schools. The World Wide Web and the Internet are used as a research tool in gathering basic information, as a method of disseminating research results, and as a form of communication among scientists, teachers, and students.

The Explorers of the Universe project relies on the students' conceptualizing the information they are learning. Two Metacognitive Tools are used by the students for this purpose. These two tools are the Concept Map and the Vee Diagram. The Concept Map relies on graphically linking ideas to allow students to see the relationships of central and subordinate ideas. The Concept Map encourages the students to explore the real relationships between concepts, rather than imposing an artificial structure on the concepts.

The Vee Diagram structures the way in which students develops their research. It is also used as tool for collaboration and interaction among students and teachers at different schools.

The left side of the Vee concentrates on the thinking aspects, i.e., conceptual and theoretical ideas, while the right side focuses on the doing aspects (methodological concepts). In the center of the Vee are the focus questions, which are the central questions being asked. The point of the Vee narrows as it goes down the page, with the focus getting more exacting and concrete. On the conceptual left, categories go from World View (vague) to Concepts (focused). The Methodological right starts with Value Claims (general) and ends with Records (exact). At the point of the Vee are the most concrete items: the events or objects involved in the research.

The goal of Explorers of the Universe is to create "communities of thinkers" within the school setting. These communities allow the classroom to become a place where ideas are shared through interactive learning in an atmosphere of coming to know through understanding and discussion. The use of MOLA data and the interaction with members of the MOLA team allows students and teachers to extend their interactions beyond the classroom and into the science research community.

The CERES project at Montana State University (MSU) reaches K-12 teachers nation-wide via web-based distance learning courses. In particular, CERES has developed a course on the Solar System aimed at upper elementary and middle school teachers. The course is designed to make use of learning modules developed by teachers which utilize NASA data, NASA websites and NASA-developed education materials. The course is designed to teach science content while modeling pedagogy and bringing Solar System exploration to the classroom.

We are currently working with the instructional design team to provide access to MOLA data and assistance in creating a search engine and Mars/MOLA-based lessons. During the 16-week course (which had a pilot offering

(Continued on Pg. 14)

Education/Outreach

The Goddard DAAC (Code 902) is part of the winning proposals for two Earth Science Information Partners (ESIP). The ESIPs are part of NASA's initiative to promote broader participation in Earth observation studies. These two proposals are to: (a) Support seasonal-to-interannual climate studies with special atmosphere and ocean data products (in collaboration with George Mason University, Center for Ocean-Land-Atmosphere, and George Washington University) and; (b) Promote the public's appreciation of NASA's Earth science data (in collaboration with NBC (Channel 4) and Fritz Hasler of Code 912).

NASA is one of the sponsors of "Earth Interactions," an electronic journal for the Earth sciences. The other sponsors are the American Meteorological Society, the American Geophysical Union, and the American Association for Geographers. The Goddard DAAC Project Scientist, Warren Wiscombe, initiated this journal with the professional societies, and the DAAC has been supporting this journal in its technical aspects from the outset. This journal is designed to incorporate multimedia in publications. All processes—manuscript submission, review, journal subscription, and publication—are done electronically over the Internet. The URL address is http://EarthInteractions.org/ .

Dr. Elissa Levine (Code 920) participated in a "WEB Chat" with GLOBE students and teachers from all over the world on December 11, 1997. The chat had questions concerning soil and Earth science, environmental issues, GLOBE protocols, and other topics.

Carla Evans (Code 902/RSTX) and Blanche Meeson (Code 900) of Scientific and Educational Endeavors (SEE) met with Laurie Murphy from Space Center Houston about potential partnerships to introduce NASA's Earth Science educational materials into their science museum and their related educational materials.

Mike Tierney (Code 920) traveled to three middle schools in New York for the purpose of education outreach. He spoke with 6th- and 8th-grade students in upstate NY. Mike spoke on topics including orbital theory and orbits for specific applications such as remote sensing, communications, and navigation. He also showed videos.

Mike has arranged to have science and engineering questions about NASA-related activities forwarded to him by several science teachers at the schools and has corresponded directly with several students.

Tom Northcutt (Code 902/Raytheon STX) participated as a judge at the 4th Annual Science Fair at Eleanor Roosevelt High School in the Environmental Sciences Category/Division.

Karsten Shein (Code 902/Raytheon) served as a judge at the Clinton Grove Elementary School, Clinton, MD Science Fair.

Carey Noll (Code 922) and Lena Iredell (Code 910/GSC) volunteered as judges for nearby Glenn Dale Elementary School's science fair in February 1998.

John Haberman (Code 915) was honored by the Hillcrest Heights Civic Association in November 1997 for his work with the librarian at G. Gardner Skhugart Middle School. He has been rehabilitating surplus computers for the students and teachers to use for both word processing activities as well as for those referencing activities normally associated with a library. For example, CDROM-based encyclopedias are now available for use by the teachers and students.

NASA and the National Park Service held a press conference March 6, 1998 at the National Park Service Visitors Center, Assateague Island, MD to discuss the results of the recent beach-mapping mission. Bill Krabill (Code 972) and Carl Zimmerman, Chief of Resource Management, National Park Service, participated in the conference, attended by local and regional media. Further information on the Assateague Survey can be found at the following URL: http://acl.wff.nasa.gov/acltm/projects.beachmap/.

As a continuation of Engineer's Week activities, Bill Krabill visited students at Greenwood Middle School and Washington High School in Princess Anne and Crisfield Middle School, Crisfield, MD.

In an effort to convey the importance of the TRMM mission to students and the educational community, an extensive TRMM Education Outreach effort is being pursued. At the request of TRMM Project Scientist, Chris Kummerow (Code 912.0), Marshall Shepherd (Code 912.0) is leading the TRMM Education Outreach effort. The goal is to identify and implement strategies that create effective educational opportunities and

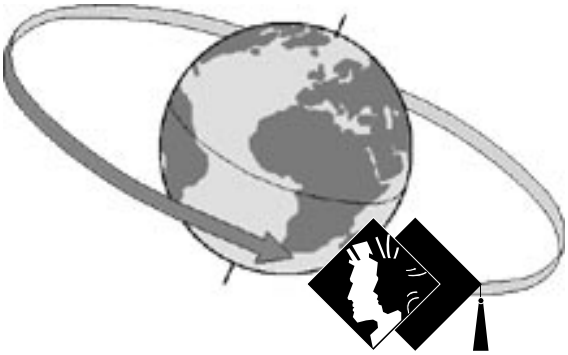
products that support NASA's Educational Goals, Goddard's Educational Framework, and national education standards. The TRMM education outreach effort is a joint effort involving TRMM scientists, Goddard's Education Office, and Goddard's Public Affairs Office.

Ali A. Jalali of the Voice of America sent a letter of commendation for Dr. Kazem Omidvar's (Code 910.3) outreach service providing information on space-related science to the Farsi Service of Voice of America. In particular, Dr. Ovidvar was recognized for his participation in a televised science panel where he answered viewers' questions.

Dr. Elissa Levine (Code 920) participated in a meeting between leaders in Agricultural Education (Department of Education, National Association of Agricultural Educators, National Council for Agricultural Education, and National Future Farmers of America Organization) and GLOBE officials to discuss integration of the nationwide ag-education network into the GLOBE program. The agricultural education community is becoming increasingly interested in expanding their "hands on" agricultural program to include more of a natural resource and environmental emphasis that GLOBE could provide. The GLOBE program, in turn, could benefit greatly by incorporating the experience and approach of ag teachers and students.

Dr. Mitchell Hobish, representing the EOS Project Science Office, gave the keynote lecture at the "Mission to Planet Earth Symposium" for northern New Jersey high school teachers at Kean University in Union, NJ.

NASA'S Earth Science Enterprise Participates In Odyssey Of The Mind



Back in 1978, Dr. Sam Micklus, professor emeritus at Rowan College of New Jersey, started an innovative program in 28 New Jersey schools that has evolved into an international program with over 13,000 schools and community programs in 50 states and 35 countries. That program, Odyssey of the Mind (OM), is now the largest creative problem-solving competition for children in the world.

Each year, the OM team comes up with a set of five new problems. Teams of five-to-seven students, under the guidance of a coach, develop solutions to a single problem that they have chosen. They are then given an opportunity to test their creative solution against those of other teams in local, regional, state, and country-wide competitions. The competitions are divided into four divisions: Division 1 (under 12), Division II (under 15), Division III (under 19), and Division IV (college students). These competitions culminate in an OM World Finals where about 5,000 students, the best of the best, compete against each other for the coveted awards in each division.

This fall, the Earth Sciences Directorate, the Earth Science Systems Program Office at Goddard, and the Office of Earth Science at Headquarters are sponsoring an Earth Science problem for these competitions. A committee, headed by Dr. Bob Gabrys of the Public Affairs Education Office and composed of several scientists from Code 900 as well as many others from GSFC and HQ, has worked feverishly with the OM team to frame the problem, which will be revealed when OM officially releases the information to the teams in August or September.

NASA's participation in the OM competitions will promote Earth Science activities in thousands of schools all over the world, while providing much positive exposure for NASA and its Earth Science Enterprise.

— Charlotte Griner

Earth Sciences Directorate Multi-Cultural Advisory Committee (MCAC)

The Earth Sciences Directorate Multi-Cultural Advisory Committee (MCAC) solicited the Code 900 Goddard community for an appraisal of the work environment. The broad-based questionnaire was composed of two sections: Section A had 16 questions relating to how well individuals feel the Directorate addresses issues related to multicultural diversity. Section B had 6 questions focusing on the treatment the individual has received at Goddard. For each question, there were five responses ranging from "very poor" to "very good." In analyzing the results, the MCAC found that overall the majority of ratings, 70 to 75%, were positive or neutral, while 25 to 30% were negative. The MCAC examined the responses in several different groupings i.e., males, females, whites, non-whites, etc.

The results, both graphical and text, are available on the Directorate homepage; however, the MCAC felt that it was useful to present its interpretation of the results in the Newsletter forum. This survey and other proceedings of the MCAC are mandated by the Earth Sciences Directorate's Multi-Cultural Diversity Plan, which is also available on the homepage.

MCAC interpretation of the Multi-Cultural Survey Results for Directorate management.

1. Key—When problems are brought to the attention of management, deal with them, addressing whatever concerns individuals have.

   a. Recognize that people from different cultures may have different concerns, emphases, and goals.
   b. Recognize that females and minorities may deal with a bad situation for a longer time, and that when they finally articulate the situation to management, it is likely that they really do deserve some attention and help.
   c. If you feel that a problem has been solved, be sure to let the individual with the problem know what has been done.
   d. Keep in mind Goal B1 of the Directorate's Multi-Cultural Diversity Plan: Allow and encourage all employees to exercise their full creativity and expertise toward Directorate goals.

2. Establish an open-door policy for regular meetings with Directorate management.

3. Attend Center activities on multicultural diversity and support them actively.

Earth Sciences News

The Newsletter of the *Earth Sciences Directorate*

Executive Editor:	Dr. Blanche W. Meeson, Assistant Director for Education and Outreach, Code 900
Co-Editor, Personnel:	Emilie Rank, Administration and Resources Management Office, Code 903
Writers:	Dr. Mitchell K. Hobish Renny Greenstone, Raytheon STX Corp.
Guest Writers:	Kathy Fontaine, Code 114 Stephanie Stockman, Code 921 Charlotte Griner, Raytheon STX Corp.
Layout Design:	Winnie Humberson, Raytheon STX Corp.

Share your news and views with your colleagues by contributing an article, photo, questions, or opinion.

Your comments are welcome and should be directed to:

Emilie Rank
Fax: (301) 286-0253
E-mail: emilie.j.rank.1@gsfc.nasa.gov

(Continued from Pg. 11)

Spotlight on Education—Bringing MARS Exploration Into The K-12 Classroom

in February 1998) the team will field test lesson modules with their 4th-8th grade classes. Lesson modules will be disseminated through the MOLA education website.

By forming partnerships with existing education initiatives, the MOLA outreach program is able to reach a national audience. Our goal is to develop and provide education materials that bring real and current science research into K-12 classrooms.

—Stephanie Stockman, Guest writer

Awards:

Dr. Mary L. Cleave, the Project Manager for the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) mission at Goddard, has been awarded the NASA Engineer of the Year award for 1998. Dr. Cleave was selected for her outstanding technical and engineering expertise in managing and coordinating the SeaWiFS Project.

Dr. Compton J. Tucker (Code 920) has been awarded the 1997 William T. Pecora Award for his achievements in the field of remote sensing. Dr. Tucker is honored specifically for his outstanding leadership in the use of remotely sensed data for ecology, and in recognition of his pioneering applications of meteorological satellite data to study global vegetation dynamics.

David N. Tucker, a senior at Eleanor Roosevelt High School, presently interning with Lawrence S. Jessie (Code 922) won a second place award at the the School's Science Fair for his Earth & Space Science project entitled: "A Comparison of Earth-like Bodies," a view of both the Earth and Mars, with special emphasis on a concept called: "True Polar Wander." True polar wander, a "sliding" of a planet's crust over the underlying mantle appears to have occurred on Earth, and evidence exists for multiple occurrences on Mars.

Dr. Robert Afzal (Code 924) and Dr. Mark Selker (former Goddard employee) have been named as Goddard's Inventors of the Year. The award was made for their 1994 invention of the high-efficiency stipe-pumped laser oscillator. This invention is being used as the seed laser for the GLAS laser transmitter and in several other lidar instruments.

Dr. James A. Smith, Code 920, was elected a Fellow of The Society of Photo Optical Instrumentation Engineers (SPIE), the International Society for Optical Engineers.

Dr. William Rossow (GISS/Code 940) has been elected to Fellowship in the American Geophysical Union.

Dr. Anne Thompson (Code 916) was designated a Fellow of the American Meteorological Society.

On March 9, 1998, Dr. Yogesh Sud, Dr. Bill Lau, Mr. Gregory Walker, and Mr. Jae-Hoon Kim, all members of the scientific staff of Code 913, were invited to a reception at the Indian Embassy, specially arranged for them to receive the 18th MAUSAM Award for best paper, given by the India Meteorological Department. The paper is entitled "Understanding biosphere-precipitation relationship: Theory, model simulations and logical inferences."

Stephen Zatman, a post-doc in Codes 921/926, was honored as having the Outstanding Student Paper in Geomagnetism at the Spring AGU.

The videotape "Images of Earth and Space: SC97 Edition" won an award of "Excellence" in the Society for Technical Communication's 1997-98 International Technical Video Competition. Andrew Acuña (formerly of RSTX/935) and Jarrett Cohen (RSTX/930) co-produced the video, which features visualizations from Goddard's Scientific Visualization Studio (935), the Jet Propulsion Laboratory, and Earth and Space Sciences Project investigators. The tape was displayed at the Society's 45th Annual Conference, Anaheim, CA, May 17-20.

Farewells & Welcomes

Departing Employees:

Connie Kroneman/Code 902
Jennifer Perez/Code 902
Aaron Brown/Code 902
Ron Seiss/Code 903
Margie Barnard/Code 903
Rose Marie Bobby/Code 903
Cynthia Lewis/Code 910*
Juan Rivera/Code 910*
David Short/Code 910
Steve Cagiano/Code 910*
Robert Frost/Code 910*
Steven Feng/Code 910*
Christa Budinoff/Code 910*
Donald Silbert/Code 910*
Georgiann Batluck/Code 910*
William Heaps/Code 910*
Patrice Cogswell/Code 910
Hanson Powers/Code 910
Nakia Reams/Code 920
Jon Rall/Code 920
James Ryan/Code 920
William Boyer/Code 920*
William Wildes/Code 920*
Roy Little/Code 920*
Lawrence Jessie/Code 920*
William Jones/Code 920*
Raymond Di Silvestre/Code 920*
Harry Montgomery/Code 920*
James Marsh/Code 920*
James C. Smith/Code 920*
Kenneth Brown/Code 920*
Patrick McClain/Code 920
Shahan Samadi/Code 920
James McLean/Code 920
Dan Lester/Code 920
Sol Glicker/Code 920
Hal Domchick/Code 930*
Thomas Moore/Code 930
Ronda Stone/Code 930
Jerome Miller/Code 930*
Igor Eberstein/Code 930*
Jim Strong/Code 930*
Harold Maurer/Code 930*
Nino Bonavito/Code 930*
Raul Garza-Robles/Code 930*
Lee Foster/Code 930*
Marilyn Mack/Code 930*
Ray Sears/Code 930*
Tom Moore/Code 930*
Mary Ford/Code 930*
E. Stassinopoulos/Code 930*
Janet Barth/Code 930*
Jean Raymond/Code 930
Les Thompson/Code 970
Eloise Rubincam/Code 970
Charles Vaughn/Code 970
Steven Bailey/Code 970*
Donald Hines/Code 970*
Donald Shirk/Code 970*
John Ward/Code 970*
Michael Triesky/Code 970*
James Riley/Code 970*
Steve Bidwell/Code 970*
James Bishop/Code 940
Inez Fung/Code 940

New Employees:

Gail Wade/Code 902
Patricia Clow/903
Cheryl Ann Barrington/Code 903
Joanne Santiago/Code 903
Michelle Renaud/Code 903
Geoffrey Bland/Code 970
Waleed Abdalati/Code 970

** Indicates employees reassigned to 500/700 as part of a reorganization*

Did you know?

The American Geophysical Union's President, Dr. Sean Solomon, appointed Dr. Ben Chao (Code 926) as an Associate Editor of the Journal of Geophysical Research (JGR)-Solid Earth through the year 2000.

Dr. James Garvin, Code 920, worked on a television program, The Learning Channel (TLC), as part of the Cool Science series which features the Iceland laser altimeter work directed by him. This program was filmed on location by a videographer for NY Times TV last May (1997).

Dr. Elissa Levine, Code 920, was interviewed for a WAMU radio show about her participation and activities in the GLOBE project. The show featured information by Dr. Levine, GLOBE headquarters personnel, and local GLOBE teachers.

Elaine Firestone (SAIC General Sciences Corporation), Senior Technical Editor of the SeaWiFs Project (Code 970.2), recently earned her certification as an Editor in the Life Sciences. She is one of approximately 210 editors in the world to have received this designation.

Dr. Robert Cahalan will be spending two months at the European Centre for Medium-range Weather Forecasting (ECMWF) in Reading, England as part of a NASA Study Fellowship. The work will deal with the "fractal" structure of clouds and its impact on evaporation and radiation in the ECMWF forecast model.

The HPCC/ESS SGI/Cray T3E is being upgraded to meet NASA's Seasonal to Interannual Prediction Project (NSIPP) computing requirements. The complete system will rank in the top five of supercomputing platforms worldwide.

Mr. Patrick Stewart (best known for his role as Captain Jean Luc Picard on the "Star Trek: The Next Generation" TV series) will be narrating a program for the Discovery Channel on Earth Sciences in October 1998. The program includes film footage of our satellite laser-ranging operations on Mt. Haleakala in Maui, Hawaii. Last year, the Geoscience Technology Office (Code 920.3) coordinated the filming at the station, which is operated for NASA by the University of Hawaii, and provided textual background material and assisted in the acquisition of archival film and tape coverage covering the launches of satellites tracked by laser.

Dr. Assaf Anyamba, a native of Kenya (and a new post doc in Code 923/GIMMS group), took part in an hour-long Voice of America TV and radio show in January on the topic of ENSO Weather Phenomena in Africa. Also taking part were Dr. Tony Busalacchi (Code 970) and McCall Stewart of NOAA.

Dr. Elissa Levine (Code 920) was named a Fellow of the Brandwein Institute, an organization of scientists, teachers, and others whose mission is to help teachers and students to acquire and practice environmental awareness through educational and research activities.

Dr. Susan Strahan (Code 910.3/GSC) has received notification that her paper "Long-lived Tracer Transport in the Antarctic Stratosphere," is a co-winner of the ESTC 1997 Publication Prize in the Environment & Geophysics category.

(Continued from Pg. 1)

A Message from the Director of Earth Science

There are many other functional changes underway at the Center that can be expected to lead to significant improvements in the way manpower and funds are tracked and managed at the Center. To name only two, the Integrated Financial Management Project will affect the way we all track our efforts, and our pending move to the Earth System Science Building (ESSB) will affect where we do our work. I appreciate the efforts of so many people to work out ESSB space assignments and associated logistical arrangements affecting the whole Directorate in very tangible and direct ways.

Looking a little farther to the future, the Earth Science Enterprise (ESE—formerly the Mission to Planet Earth Enterprise) is updating its Strategic Enterprise Plan and associated metrics. I have read this plan and associated documents and made them available to the Directorate Senior Staff for comment and to pass on to you. I recommend that you read these documents so as that each of you will have a clear sense of where the Agency efforts are directed and how we, as a Directorate and individually, can formulate our plans so to contribute and be as viable as possible. The ESE plans are available, or will be available in the near future (see URL http://www.hq.nasa.gov/office/mtpe/). Concomitantly, the Center is creating action plans associated with the Center Strategic Implementation Plan and the results of the Culture Survey (soon to be released to all employees). Each Directorate is— and will continue to be—responding to those actions in various ways, including updating Directorate Operational Plans (ours is on the Directorate Home Page). I recommend that you strive to understand all of these documents and activities. I pledge, along with the rest of the Directorate Senior Staff, to put forth my best effort to keep you informed, answer questions, and provide guidance as appropriate.

We have many exciting changes (along with technical and administrative challenges) to look forward to in the near and far future. At times the challenges and changes may seem a bit overwhelming, but I believe that Goddard is, as it has been historically, a great place to work and it has great possibilities for remaining that way in the future and becoming even better. I urge us all to work together to ensure that is the case.